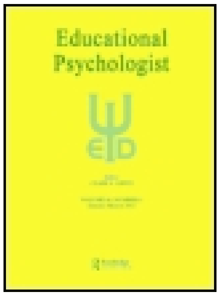

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New Conceptions of Thinking: From Ontology to Education

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Current efforts both to conceptualize good thinking and to teach thinking are dominated by what might be called the *general processes* view, which holds that good thinking consists in a number of general cognitive processes supported by appropriate skills and strategies. This view suggests that thinking works top–down through the activation of general processes that access context-specific knowledge and call subprocesses. However, contemporary scholars in this issue and elsewhere have proposed constituents of good thinking quite different from processes, strategies, and skills—in effect a broader ontology of the kinds of things that figure in good thinking. We define three categories in this broadened ontology in addition to processes: the language of thinking, abstract conceptual structures, and dispositions. It is argued that these categories bring with them a less top–down view of how thinking works: Different constituents of thinking are activated by the particulars of an occasion of thinking and by one another in a process that might be termed *coalescence*. The greater range of constituents and the nature of coalescence call for a richer conception of teaching thinking. It is suggested that the notion of enculturation provides such a conception.

What is good thinking made of? A number of authors have advanced views about the nature of good thinking. Some have urged the importance of general thinking strategies (e.g., Hayes, 1981; Polya, 1954, 1957). Others have highlighted general cognitive and metacognitive processes that might be improved by practice or reorganization (e.g., Feuerstein, 1980; Sternberg, 1985). Still others have written of general searches that provide the fundamental logical structure of thinking (e.g., Baron, 1985). In this special issue, several other researchers share their visions of the fabric of

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effective thinking. These views are not inconsistent with one another. Indeed, it is argued in the following pages that they can, by and large, be combined. However, their obvious contrasts raise questions as to the real nature of the factors that underlie good thinking.

The very uncertainty recommends giving what comprises thinking a generic name for a placeholder. Let us speak of "mindware." This term refers to whatever learnable processes, schemas, sensitivities, attitudes, and so on, foster good thinking. It holds at arm's length just what kinds of things these are. But having a placeholder term helps in asking four very basic questions:

1. *What kinds of mindware are there?* This is essentially an ontological question. It asks what fundamental kinds of learnable things in some sense exist in the mind and foster good thinking.
2. *How does mindware of various kinds get activated?* That is, how does a particular situation evoke whatever mindware might be relevant?
3. *How does mindware of various kinds contribute?* That is, how does mindware make thinking better?
4. *How is mindware acquired?* That is, what kinds of learning or developmental processes suit various kinds of mindware?

These four questions afford a framework for analysis in the following pages. The initial sections of this article focus on the first three questions. After touching on a definition of good thinking, the dominant but limited view of general processes is introduced and the answers it provides to the three questions reviewed. Then some alternative analyses of thinking are surveyed. These call for an expanded picture of mindware and of how thinking works.

Then the focus shifts to Question 4: How is mindware acquired? We argue that the expanded picture demands an approach to teaching and learning that is fundamentally different from that usually found in efforts to teach thinking—education as enculturation.

A PRAGMATIC CONCEPTION OF GOOD THINKING

Our analysis requires a conception of good thinking as a point of departure, one that does not beg crucial questions. For purposes of this article, we adopt Baron's (1985) pragmatic view of good thinking as thinking that achieves its ends.

Baron proposed that thinking fundamentally addresses decisions, beliefs, and goals, including decisions about what beliefs to believe and what goals to pursue. Good thinking, for example, yields beliefs that are functional in

the world as the person encounters it, decisions that advance the person's general goals, and so on. When people face problems that require critical judgment, good thinking involves making the best of what one knows to yield a good judgment. When people face problems that call for creativity, good thinking demands flexible, imaginative exploration. Thinking-in-action is assessed much as one might assess a carpenter's tool kit, according to whether it has the resources to handle the jobs at hand.

Baron's basic conception leaves open a question that will prove crucial in the coming pages: context specificity. His conception allows that good thinking may prove highly contextual, varying from setting to setting.

At the same time, Baron and many others have pointed out a number of general problems and challenges that stand in the way of good thinking. For example, Baron (1985), with many others, noted that people commonly conduct shallow searches for options, beliefs, and goals, and so miss important alternatives. A number of investigators have logged questionable patterns of reasoning concerning probability and statistics (Kahneman, Slovic, & Tversky, 1982). Feuerstein (1980) identified several generic respects in which slow learners handle information poorly. Kuhn (1991) showed experimentally how people often reason with evidence poorly, even in areas where they are knowledgeable. Perkins and Swartz (1992) emphasized that human thinking typically suffers from four defaults, tending to be hasty, narrow, fuzzy, and sprawling.

The issue of context specificity will be revisited later. Meanwhile, the problems identified previously suggest that thinking that achieves its ends needs to meet a number of rather general challenges that cut across contexts. What kind of mindware might help thinking to do so?

THE GENERAL PROCESSES VIEW

One dominant view might be called the *general processes* view. It offers a parsimonious ontology of good thinking: General cognitive processes make up the substance of the thinking enterprise. It avers that good thinking can be usefully analyzed in terms of a number of general processes. These processes serve various general categories of thinking. Sometimes the focus falls on general common-sense processes, such as decision making, problem solving, or understanding. Sometimes processes of a more technical psychological turn are emphasized, such as memory retrieval, encoding of information, or classification of problems. One especially important cluster of processes is metacognition, the self-monitoring and self-adjusting of the ongoing thinking process by the thinker.

These processes contribute to good thinking to the extent that they are skillfully and strategically executed. Strategies most typically are process

prescriptions. They specify steps to follow, in effect organizing a process into subprocesses. Skills are usually considered to be constituent subprocesses for which the learner develops precision and fluency. How well thinking achieves its ends depends considerably on what repertoire of skills and strategies a person has and how well they work.

The general processes view is not so much advocated as such by any one investigator as it shows through the theories and practices of a number of psychologists and educators. For example, Sternberg's (1985) well-known triarchic theory of intelligence analyzes thinking into a number of processes, including an elaborate set of metacognitive processes, such as recognizing that a problem exists, recognizing the nature of a problem, and selecting mental representations suitable for the task. Project Intelligence (also called Odyssey), a program to teach thinking, instructs students in strategies for decision making, problem solving, creativity, and other kinds of thinking (Herrnstein, Nickerson, Sanchez, & Swets, 1986). The well-known CoRT program developed by de Bono (1983) teaches students strategies labeled with acronyms—PMI for listing the plus, minus, and interesting points about something and CAF for considering all factors. Feuerstein (1980) based his Instrumental Enrichment program on an analysis of characteristic information processing difficulties exhibited by retarded performers; the program emphasizes a process of coaching learners in tasks that highlight these processes, with great attention to metacognitive control. A number of other approaches with a similar character were discussed by Nickerson, Perkins, and Smith (1985).

The general processes view answers the first three questions listed earlier as follows (the fourth will be discussed later):

What kinds of mindware are there? There are cognitive and metacognitive processes, including strategies that organize processes and skills that ensure their fluent execution.

How does mindware of various kinds get activated? It is presumed that people recognize occasions when a process, skill, or strategy might apply and proceed to apply it. A general process, for example, problem solving or decision making, gets evoked and calls on more specialized subprocesses. A more technical backdrop comes from the artificial-intelligence-based research on production systems as models of cognition: The preconditions of productions "fire," launching processes (Anderson, 1983; Newell, 1990).

How does mindware of various kinds contribute? Processes in general contribute by undertaking information processing jobs that need to be accomplished, for instance, generating ideas or formulating judgments. Strategies—in effect, process prescriptions—contribute by guiding the deployment of cognitive resources. For example, a typical decision-making strategy recommends generating a wide range of options as one step. This focuses the thinker's cognitive resources on option generating specifically.

Metacognitive processes contribute through a control function, monitoring and managing the ongoing stream of thought.

The Top-Down Story Line of Thinking

The answers to the three questions come together into an idealized story line about what happens when people think well. The thinker encounters an occasion of thinking. For example, let us say that you find in the morning's mail an invitation to sign up for a credit card. The occasion activates a general process for decision making from your repertoire: You want to decide what to do about the credit card invitation, and you approach it as a general decision-making situation in which you need to search out options, evaluate them, and make a choice.

Accordingly, your overarching decision-making process calls up appropriate subprocesses, such as formulating options (e.g., accept the invitation, reject it, accept but drop another card, etc.). As you continue through other phases of your decision-making process, you monitor yourself metacognitively to make sure you attend carefully to each phase. The factors are weighed, and finally, a decision is reached.

While decision making surely proceeds in a messier way in many circumstances, this highly structured, rather linear story line represents an ideal of thinking well controlled by a superordinate process. Because of the dominant pattern from general process to subprocesses, one might speak of the "top-down" story line.

THE CHALLENGE FROM EXPERTISE

The general processes view faces a fundamental challenge from another contemporary analysis of mind, the expertise view. Considerable research over the past 30 years suggests that sophisticated thinking virtually always reflects a rich knowledge base in the domain in question, be it chess playing, physics problem solving, medical diagnosing, or another (Ericsson & Smith, 1991; Glaser, 1984). General strategies in themselves have proven to be a poor substitute for such a knowledge base.

Accordingly, the expertise view has a somewhat different response to the first three questions, again deferring the fourth. As to kinds of mindware, the expertise view highlights the importance of context-specific knowledge and processes. As to activation, for the expert, circumstances typically evoke highly domain-specific knowledge and processes, rather than general processes that reach down to the particular via subprocesses. As to how mindware contributes, context-specific knowledge helps the thinker to handle challenging situations with a degree of orientation and attention to

nuance that general processes simply do not allow. Sometimes the implication seems to be that general strategies and skills are not very important.

The Bottom-Up Story Line of Thinking

The expertise view also provides a somewhat different story line for a thinking episode than the top-down story line of the process view. Again, imagine that you have received a credit card invitation in the mail. The circumstances evoke your knowledge base of prior experience with such matters. You may already have a policy of ignoring such solicitations. You act on this at once and toss the invitation in the wastebasket, hardly thinking about it at all. You are already an expert in what to do!

Only if there were something especially enticing about the offer or you had recently noted a need for another card would you engage in much thinking at all. Even then it would be highly contextual, driven by your prior experience with credit cards and credit, interest rates, and so on. You might never ask yourself any conspicuously general strategy-like questions, such as "What are my options?" or "What are the consequences?" Because of the way the process moves from particular established responses when they fit (toss it in the wastebasket) toward the somewhat more general if necessary, one might speak of the "bottom-up" story line.

Despite this different story line, the general processes and the expertise views share a common theoretical landscape. Both reflect a process perspective and respect knowledge-compilation of learning. They differ principally on the importance of general cross-domain processes versus particular highly contextualized knowledge and processes, a tension to be revisited later.

NEW CONCEPTIONS OF THINKING

Recently, researchers have advanced several conceptions of good thinking that expand our notions of what kinds of mindware there are. Other articles in this special issue present four such views. None of these conceptions denies outright the general processes and expertise views. Rather, they supplement and enrich the story of thinking by emphasizing dimensions of mind that tend to be neglected. The conceptions represented in this issue can be classified as the language of thinking, abstract conceptual structures, and thinking dispositions.

The Language of Thinking

The language of thinking consists of natural language terms that refer to mental processes and mental products. Words like *think, believe, guess,*

conjecture, hypothesis, evidence, suspect, doubt, and *theorize* form a vocabulary used to describe thinking. Such terms convey information about matters like the certainty of the speaker (consider differences between *think, believe,* and *know*) or the degree of evidence required (compare *speculation* and *theory*).

This language of thinking is more than just a set of convenient labels. Conceptual development is involved. Olson and Astington (1993) make the case that good thinking requires competence with concepts for managing how beliefs are to be held and how statements are to be taken. It involves the acquisition of conceptual categories that describe the nuances of one's own thinking, for instance, making an assumption versus a hypothesis. A rich language of thinking equips one for sophisticated metacognition. In addition, a language of thinking allows comprehending the illocutionary force behind the statements of others.

What does the concept of a language of thinking contribute to the present discussion? Let us revisit the questions of what kinds of mindware there are, how they are activated, and how they make their contributions to good thinking.

- *Kind:* The language of thinking consists of terms (with the concepts that go with them) for mental processes and products. This entails a range of reference much broader than with strategies, which, as noted earlier, are process prescriptions.
- *Activation:* A language of thinking is activated by situations that invite verbally mediated reflection or communication that addresses thought processes or products. Again, this range of occasions is plainly much greater than that for evoking strategies.
- *Contribution:* The language of thinking contributes to management and communication of thinking in much the same way that other specialized vocabularies contribute to their realms: through providing terms and concepts that identify important categories and significant discriminations. Again, the scope is far greater than that of strategies.

Abstract Conceptual Structures

The epistemic forms and games described by Collins and Ferguson (1993; see also Perkins, 1992) and abstract schemas as conceived by Ohlsson (1993) both represent our category of abstract conceptual structures. Epistemic forms are frameworks for constructing explanations, with epistemic games the varied activities played out to put these forms to use. Some examples of epistemic forms are hierarchies, stage models, system-dynamics models, multifactor analysis, axiom systems, and cost–benefit analysis. Epistemic forms are generative frameworks with fillable slots and designated con-

straints, rather than specific knowledge, schemas, or strategies. For instance, hierarchical classification systems occur as explanatory devices in many contexts and fields. Whether highly general, like compare-and-contrast forms, or special to a discipline, like axiom systems, their function is epistemic in nature: They guide the building of knowledge structures.

In a similar vein, Ohlsson developed the notion of abstract schemas. Such schemas represent the structure of a process or pattern, removing it from the particulars of the content. Consequently, they become truly mobile forms accessible for discourse and retrieval at an abstract, high level. For instance, Darwin offered the theory of natural selection for organisms. From this, one can draw out the abstract schema of the Darwinian explanation pattern—variation, selection, and retention. This can be and has been applied to many other contexts besides that of biology. Ohlsson offered three categories of abstract schemas, including descriptive schemas (e.g., genealogical trees), explanatory schemas (e.g., Darwinian explanation pattern), and compositional schemas (e.g., atomic models).

Let us examine how the notion of abstract conceptual structures speaks to the questions of kind, activation, and contribution.

- *Kind:* Abstract conceptual structures specify patterns to be filled out rather than steps to follow, as do strategies.
- *Activation:* Of course, abstract conceptual structures may be activated by situational cues. However, Ohlsson (1993) emphasizes that abstract schemas of powerful thinkers are activated from within, by the thinker's intellectual agenda, in situations that do not offer obvious cues.
- *Contribution:* In contrast to providing process prescriptions, as strategies do, abstract conceptual structures contribute to thinking by providing general goal structures, such as that of constructing a hierarchical classification system or a Darwinian explanation. Choosing a contextually appropriate abstract conceptual structure and working to instantiate it helps to organize inquiry.

Thinking Dispositions

The concept of mindfulness, outlined by Langer (1993), can be viewed as an overarching disposition toward handling activities in a thoughtful, alert way. Through numerous experiments, Langer has demonstrated that often people function in what she calls a mindless manner, missing significant anomalies in seemingly routine situations and making premature cognitive commitments. In contrast, mindfulness involves a broad spectrum alertness to the world. It is an open, creative, probabilistic state of mind "that results

from drawing novel distinctions, examining information from new perspectives, and being sensitive to context."

In general, *dispositions* can be defined as people's tendencies to put their capabilities into action. Mindfulness can be considered a disposition because it has to do with how disposed people are to process information in an open, alert, flexible way—something Langer's studies show that they are quite capable of doing. Similarly, Salomon (1983) discussed the importance of the investment of mental effort in learning. Looking at a more specific aspect of thinking, attention to diverse points of view, Perkins, Farady, and Bushey (1991) showed that people can easily generate reasons on the side of an issue opposite their own when prompted to do so (they have the capability) yet generally tend not to do so (they lack the disposition).

In sum, what often distinguishes good from average thinkers is not simply superior cognitive ability, but rather their thinking dispositions—their abiding tendencies to be mindful, invest mental effort, explore, inquire, organize thinking, take intellectual risks, and so on. A dispositional account of thinking thus challenges the dominant general processes view, which focuses on abilities. Several theorists (e.g., Baron, 1985; Ennis, 1987; Passmore, 1967) have discussed the importance of dispositions, contrasting them with abilities. A more differentiated dispositional theory is offered by Perkins, Jay, and Tishman (in press) who explained thinking in terms of abilities, inclinations, and sensitivities.

The notion of thinking dispositions adds the following to the three mindware questions:

- *Kind:* Behavioral tendencies in contrast with capabilities.
- *Activation:* Broad dispositions like mindfulness are abiding tendencies. They do not so much get activated as do the activating; that is, a mindful person tends to function mindfully in circumstances that do not directly and emphatically stimulate mindfulness. Of course, it is also reasonable to speak of more contextual dispositions evoked by particular situations, such as the disposition to listen carefully to other points of view in the midst of an argument.
- *Contribution:* Basically, dispositions activate other sorts of mindware. For example, a disposition to be open-minded can activate strategies for seeking alternative interpretations. Dispositions are essential to putting good thinking into practice because unless one has an inclination to use it, ability will lay fallow.

HOW GOOD THINKING WORKS: AN EXPANDED VIEW

One need not choose among the preceding views of good thinking or between them and the utility of strategies and skills. The mind is a roomy

place, able to accommodate strategies, dispositions, mindfulness, abstract schemas, epistemic forms and games, the language of thinking, and more.

Instead of a turf war for the true name of good thinking, what emerges from these and other contemporary writings about the character of thinking is an enriched ontology of mind, a more panoramic picture of the kinds of mindware that figure importantly in thinking (cf. Ohlsson, 1990). With this comes more varied answers to the key questions, as already discussed. In addition, there are insights regarding the role of generality in thinking and a fresh story line for thinking.

The Importance of the General

With this diversified mindware comes a partial rebuttal of the challenge from the expertise view. Although the argument from expertise questions whether general mindware has much to contribute to good thinking, the expanded ontology helps to explain why and how it should.

First of all, much of the mindware considered earlier plainly ranges in character from very general to highly context specific. For instance, epistemic games can be as general as compare and contrast or as specialized as trend analysis, or more so. This expanded view thus tends to dissolve the dichotomous contrast between the general and the particular, revealing a spectrum instead.

Second, the language of thinking, epistemic games, and related notions disclose a complex world of explicit ideas about thinking in common use within and across fields. Because the processes, skills, and strategies of the general processes view are often not overt outside of instructional contexts, if one only attends to these one might conclude that there is not much richness to tap. In contrast, the variety and complexity of language about thinking, abstract conceptual structures, and dispositions suggests that there is an explicit expertise about thinking itself.

Third, the abstractness and yet evident power of the language of thinking, abstract conceptual structures, and dispositions make them appropriate for transfer across domains. Their explicit articulate nature makes them suitable for deliberate thoughtful transfer or, as Salomon and Perkins dubbed it, "high road transfer" (Perkins & Salomon, 1987; Salomon & Perkins, 1989).

Fourth, the notion of mindfulness and its contrastive notion of mindlessness remind us that expertise functions best in routine situations. It is exactly under circumstances of novelty that reliance on repertoire falters and more general mindware may be needed, in company with domain knowledge, to steer a successful path (see also Perkins & Salomon, 1989).

The Coalescence Story Line of Thinking

With all this said, any account of good thinking has to recognize the power of the particular as articulated in the research on expertise. In many circumstances, what was termed earlier the top-down story line simply will not do. One deals with the particular occasion through particular responses, which may be virtually automatic or sometimes more thoughtful—the bottom-up story line. Not only do these story lines need to be reconciled, but both need to recognize that more than knowledge and processes are involved in episodes of thinking.

A revised story line that accomplishes these aims might be called the *coalescence* story line. Returning again to our case of the credit card invitation, the tale might go something like this: The invitation arrives. In the simplest case, you have a firm policy of no new credit cards, so the story ends quickly with the letter in the wastebasket. However, if something gives you pause, a variety of mindware at different levels of specificity may get invoked. Perhaps the invitation reminds you of other credit cards you have. This pulls in the idea of comparing. That in turn pulls in the disposition of proceeding carefully, which invokes a systematic compare-and-contrast epistemic game. This stimulates some specific knowledge about prior experience with credit cards. You may recall and apply a full-fledged decision-making strategy or simply muddle around in the decision-making situation awhile and then decide.

In this story line, there is no one set process, top-down or bottom-up. But there is a reservoir of resources—the mindware—that coalesces around the situation so long as you sustain attention. One kind of mindware tends to draw in others. There is a great mix of more and less context-specific mindware and of different kinds of mindware.

THE CHALLENGE FOR LEARNING AND TEACHING

Let us consider the fourth question raised earlier, how is mindware acquired? In the general processes view, acquisition means learning and becoming fluent with a repertoire of thinking skills and strategies. Programs designed to teach thinking typically employ what might be termed a transmission and practice model of instruction: The programs transmit to learners strategies for important categories of thinking, such as decision making, solving problems, or more specifically, solving problems in mathematics. Then, the programs provide practice in applying the strategies.

In our view, this transmission and practice model of the teaching/

learning process is an appropriate way to teach thinking skills and strategies. However, the expanded ontology of thinking proposed here must be considered. Now the learning must accommodate a multiplicity of mindware, including the language of thinking, abstract conceptual structures, and dispositions. Because these sorts of mindware are considerably different in nature from processes with their strategies and skills, they pose some new demands.

Developmental change in concepts of mind. Olson and Astington's (1993) work on language of thinking argues that progress toward higher level thinking relies on the development of richer conceptual categories to think about and describe thinking. Work on children's conception of mind demonstrates that development of such conceptual categories involves the emergence of a sophisticated network of beliefs about one's own and others' minds (Leslie, 1988; Wellman, 1990). Such change is slow and hard won because it is a process of developmental reconceptualization. Even an enlightened transmission model of teaching is not likely to meet the challenge of this kind of developmental change.

Acquisition of shared abstract conceptual structures. Epistemic forms and abstract schemas involve taking in whole analytical perspectives, not just executing strategies. For example, the Darwinian explanation pattern, axiom systems, or system-dynamics models (Collins & Ferguson, 1993; Ohlsson, 1993) constitute complex conceptual systems, including an analytical style and a way of viewing things. They are not easily taught as stepwise strategies. More typically, they develop slowly within the context of mastery of particular disciplines that foreground them, a matter of learning that is "situated" in meaningful contexts (Brown, Collins, & Duguid, 1989).

Assimilation of values and development of habits of mind. Dispositions depend considerably on underlying values and belief structures, so acquiring and sustaining them requires the assimilation of value and belief systems. For example, the disposition to be open-minded rests on values and beliefs about the importance of acknowledging other perspectives. Also, dispositions, as abiding habits of mind, are likely to be slowly acquired. One can transmit the maxim that people ought to be open-minded, but knowing the maxim, or even practicing it some, is not likely to cultivate a commitment to open-mindedness.

The challenge then is to find a conception of learning and teaching flexible enough to accommodate the multiplicity of mindware. Moreover, it must take into account the diverse and flexible patterns of interaction among these kinds of mindware, what was called earlier the coalescence

story line. Perhaps the place to look is the most ordinary context in which teaching and learning happens: everyday culture.

EDUCATION AS ENCULTURATION

Consider our body of practical knowledge. All of us have learned much of what we know about day-to-day living through cultural involvement. On the most general level, we come to participate in accepted social behaviors, to recognize societal expectations and norms, to engage in typical social activities, and to hold certain beliefs.

Yet the acquisition of cultural knowledge is by no means a simple process: We learn many kinds of things in many kinds of ways. For example, etiquette is a kind of cultural knowledge that we acquire variously, through observation, direct instruction, practice, and so on. Compare this with another type of cultural knowledge, everyday knowledge of human psychology. We learn how to predict and explain people's behavior in much the same way that we learn good manners, by watching, experiencing, listening, acting, and talking. Yet human psychology is a different kind of knowledge than the rules of etiquette. It is not surprising that cultural learning has this scope, because we expect cultural influences to be pervasive and complex—pervasive enough to teach such diverse kinds of knowledge as etiquette and psychology, and complex enough to integrate several modes of learning, such as observation, experience, direct transmission, and interaction.

This broad and complex process of acquiring cultural knowledge can be termed *enculturation*. Perhaps it has the span and subtlety to provide for the teaching of diverse mindware. Can enculturation really fill this agenda? There are reasons for an affirmative answer. Cultural influences such as language shape cognitive developmental processes (Astington & Olson, 1990); traditional cultural institutions like apprenticeships influence the learning of complex conceptual structures (Collins, Brown, & Newman, 1989); cultural contexts enable situated learning (Brown, Collins, & Duguid, 1989); and, through culture, intellectual values and dispositions are modeled and acquired (Tishman, Jay, & Perkins, in press).

Four Dimensions of Enculturation

It is useful to think of enculturation as occurring in four distinct but mutually reinforcing ways:

1. Cultural *exemplars* are artifacts and people modeling or otherwise exemplifying cultural knowledge.

2. Direct *transmission* of key information is the straightforward teaching of concepts, vocabularies, and information related to cultural knowledge.
3. Involvement in cultural *activities* entails hands-on practice using aspects of cultural knowledge.
4. Involvement in cultural *interactions* refers to learner/learner and mentor/learner interpersonal exchange using and embodying cultural knowledge.

These four dimensions of enculturation apply to any kind of cultural knowledge, from the culture of the workplace to the culture of surfing. They can be interpreted as guidelines for organizing instruction because each element of the quartet enjoins specific kinds of teaching activities.

Dimensions of enculturation are better illustrated than described. The following example outlines a teaching episode that shows how an enculturation model may apply to the teaching of thinking. The episode is based on an illustration of multifactor analysis offered by Collins and Ferguson (1993), although almost any abstract conceptual structure, disposition, or small subset of the language of thinking could serve as the point of departure.

An Example of Teaching Thinking by Enculturation

What makes rice grow? This is the question an eighth-grade teacher wants his students to be able to answer and explain. His class is studying the agriculture of East Asia, and the teacher sees an opportunity to teach students how to construct explanations of phenomena such as rice growth, in which multiple factors play a causal role. He tells the students that in today's lesson they will explore causal reasoning and begins class with the following monologue, designed to model for students what a causal story line with multiple factors might sound like:

> Have you noticed that the roses in the park bloomed early this year? I'm asking myself why. What factors caused these early blooms? I recall that it was a warm winter. That was probably an important factor. But certainly there are other factors involved—probably some hidden ones—and I know it is important to search for them. In fact, now that I've stopped to think, I remember that we had very heavy rains in March. This may be a factor, too. . . .

After concluding this "think aloud" monologue, the teacher goes on to point out other situations that take into account multiple causal factors, such as medicine.

He then gives the students some straightforward information about playing the causal analysis game. For example, he explains the "and/or" conventions for showing how causal factors may contribute jointly or exclusively to a phenomenon and demonstrates how to construct a diagram that represents a multifactor analysis (see Collins & Ferguson, 1993).

Next, the teacher engages the students in the activity of playing this epistemic game themselves. Returning to the topic of Asian agriculture, he asks: "What are the causes involved in rice growth? Can you draw a diagram illustrating the contributing factors and how they contribute?"

The teacher knows that multiple causes are not always apparent and that it is important to cast a wide net for potential factors. He therefore urges the students to be broad in their thinking and to consider the effect of a variety of factors, such as weather patterns, terrain, and insects.

When the students finish their diagrams, the teacher asks them to discuss the activity with a partner. He tells them to examine each others' charts and to discuss their learning experience with each other by responding to specific questions, such as "How did you identify a variety of causes?" "Was it hard to determine how factors might be causally linked?" "What questions can you invent about the multifactor analysis game?" "Where else might this kind of analysis be useful?"

After the lesson, the teacher posts students' diagrams on the classroom wall, where they serve as ongoing visual exemplars embedded in the classroom environment. In the following weeks, he stays alert to opportunities to fold the notion of multiple causal factors into the regular pattern of classroom activities. For instance, in a discussion of local government, he points out how several factors come into play in determining voter turnout in a local election. In a science project involving oak trees, he challenges students to identify several factors contributing to the growth of a crop of particularly leafy seedlings. More broadly, he keeps the language of causal analysis alive by taking care to use terms such as *cause* and *factor* frequently and by eliciting such language from students as well.

The Dimensions of Enculturation at Work

Let us examine this teacher's story more closely, first looking at how the episode as a whole reflects the four dimensions of enculturation and then, in the next section, identifying the different kinds of mindware that come into play.

1. *Exemplification:* In the teaching episode just described, the teacher exemplifies the target mindware in two ways. He models aloud the game of causal analysis, thus providing for students a mental image of a player

playing an epistemic game. He also points out other exemplars of the epistemic game in the area of medicine.

2. *Transmission:* In the same way that the rules of chess are key items of information for the chessplayer, the rules and constraints governing causal analyses are key items of knowledge for the good thinker. The teacher duly transmits them straightforwardly. He also transmits key graphic information by drawing a diagram of a multifactor analysis on the blackboard.

3. *Activities:* A crucial mode of enculturation is participation in cultural activities. The teacher engages students as active players in the game of causal reasoning by asking them to construct and diagram a multifactor analysis of rice growth themselves.

4. *Interaction:* The language and concepts of causal reasoning are introduced into learner/learner interaction when the teacher asks students to respond to each others' work and to discuss their learning experiences with one another.

How Enculturation Helps Mindware to Coalesce

In his lesson on the agriculture of Asia, the teacher begins with an ostensible focus on causal reasoning. However, closer inspection of the preceding episode shows that the enculturative model shapes this teacher's pedagogy so that it almost automatically activates a range of additional mindware beyond the target epistemic form of multifactor analysis of causes.

For example, in the context of providing exemplars, the teacher models some powerful thinking dispositions, particularly the disposition to be strategic ("I know it is important to search [for other factors]") and the disposition to be metacognitive ("now that I've stopped to think"). Also, by pointing out exemplifications of multifactor analyses in other contexts, such as medicine, he helps enculturate values associated with the explicit transfer of knowledge.

In the context of direct transmission, the teacher naturally uses terms associated with causal reasoning, activating the language of functional analysis and associated concepts. As students engage in causal analysis, the teacher urges them to conduct a broad search for potential factors, perhaps drawing in skills and strategies relevant to search.

As students work and talk together, the language of functional analysis again comes into play. Also, by asking students to reflect together on their learning experience, the teacher sanctions and promotes the disposition to be mindful and metacognitive. Thus, the enculturation model of teaching serves the ontological and functional diversity of mindware by creating a learning environment that triggers several kinds of mindware in the same teaching episode.

Notice how, although the ostensible target of instruction may vary, an

enculturative approach will almost certainly stimulate the coalescence of several kinds of mindware, so long as the teacher is focusing on teaching some aspect of thinking. For example, a teacher may design instruction around a thinking disposition rather than an epistemic form, perhaps the disposition to seek reasons. By following the enculturative quartet of exemplars, transmission, activities, and interactions, the lesson will most likely also draw in such additional mindware as reason-seeking skills and strategies, vocabulary and concepts associated with reasoning, and abstract conceptual structures that provide a framework for reasoned explanations.

CONCLUSION: FROM ONTOLOGY TO EDUCATION

We began by asking what good thinking is made of. Or, to use the placeholder term, what kinds of mindware are there? Three further questions were added to the inquiry: How do various kinds of mindware get activated? How do they contribute to good thinking? and How do they get acquired in the first place? The dominant general processes view answers that mindware consists mainly in processes supported by skills and strategies, activated by the stimulus of the situation and by calls to subprocesses, contributing through strategies and skills that organize and streamline processes, and acquired through transmission and practice. The story line of an ideal episode of thinking can be characterized as top–down.

The expertise view answers somewhat differently: Mindware consists largely of context-specific knowledge and processes, activated by the nuances of the context, contributing through the context-specific knowledge of expertise, and acquired through situated learning. The story line of thinking may be characterized as bottom–up.

The synthesis view offered here seeks to accommodate features of expertise; the processes, strategies, and skills of the general processes view; and other general kinds of mindware, such as the language of thinking, abstract conceptual structures, and dispositions. This expanded ontology leads to more diversified answers to how mindware become activated, make their contribution, and get acquired. An appropriate story line for thinking may be called coalescence, in which the particular situation evokes some kinds of mindware, which draw in others in flexible ways specific to the occasion.

All this, in turn, calls for a richer conception of how good thinking should be taught. Culture on a general level reflects the irrefutably complex structure of social organization. Taking a cue from this observation, we argue for an enculturative approach to teaching thinking. Such an approach offers a powerful framework for organizing instruction and honors the complex ontology and coalescent organization of good thinking.

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